# *Implementation of 'My Guardian Angel' – A Smart Wearable Device – in a Sheltered Home in Singapore*

Nicholas Netto, Singapore University of Social Sciences, Singapore

The European Conference on Aging & Gerontology 2023
Official Conference Proceedings

**Abstract**
Singapore is one of the fastest ageing countries in the world, with the proportion of citizens aged 65 and above increasing from about 11% in 2012 to an estimated 25% by 2030. To tackle this 'silver tsunami', the 2023 Action Plan for Successful Ageing aims to empower older persons to lead healthy lives while ageing-in-place. As falls are a leading cause of injury-related hospitalisation, this is a major concern in Singapore. This paper will describe the implementation of 'My Guardian Angel' (MGA) – a smart wearable device – in a Singaporean Sheltered Home (SH) for ambulant older persons. The device is novel in that it not only uses wearable sensors to detect and respond expediently to falls, but also encompasses other features which seek to improve the quality of life of older persons living in the SH. The features of the MGA include: (a) 'Mealtime Attendance Taking' that alerts staff if residents miss a meal; (b) 'Laundry Management System' where laundered clothes are tagged and tracked; (c) 'Access Control System' that serves as an 'pass' to residents' rooms and enhances their privacy; and (d) 'Fall Detection System' in which falls detected by the MGA would push the location of the fall to a staff's tablet who is then able to respond immediately. The paper will provide an overview of the MGA, and offer insights into the benefits, challenges as well as feasibility of implementing its components in an institutionalised setting for older persons in Singapore.

Keywords: Gerontology, Healthy Ageing, Health Technology, Institutionalized Living, Quality of Life

## 1. Introduction

Singapore is one of the fastest ageing countries in the world. The proportion of Singapore citizens aged 65 and above had increased from 11.1% in 2012 to 18.4% in 2022, and will rise to almost 25% by 2030 (National Population and Talent Division et al., 2022). To tackle this 'silver tsunami,' the government launched the 2023 Action Plan for Successful Ageing to address these issues, which aimed to strengthen support networks and to empower older persons to lead healthy lives while ageing-in-place (Ministry of Health, 2023).

Older adults who are physically active are less likely to experience falls and fall-related injuries (Lee et al., 2022), and improve the probability of maintaining physical, mental and social health as well as enabling healthy ageing (World Health Organization, 2018). However, one in three community-dwelling older persons aged 65 years and above will still be expected to have at least one fall within a year (Ang et al., 2020), and falls are a leading cause of injury-related hospitalisation among this population in Singapore (Health Promotion Board, 2015).

### 1.1 St. John's Home for Elderly Persons

In the Singapore context, Sheltered Homes (SHs) provide accommodation to older persons who are Activity of Daily Living (ADL)-independent (i.e. are able to move about and care for themselves on their own), but who do not have family members or caregivers to look after them (Agency for Integrated Care, n.d.). ADL-independent is measured by the Resident Assessment Form (RAF) which assesses the functional status of residents on nine indicators with a scoring system rating them from one to four (Lim & Ng, 2015). For SHs, a resident needs to obtain a score of 15 and below (i.e. Category 2) to be eligible for admission.

St. John's Home for Elderly Persons (SJH) was established in 1958 and is an SH for ambulant older persons aged 60 and over; it is also a registered charity in Singapore. SJH used to be located in an old converted military barrack which occupied a single-storey over a large piece of land. SJH moved into a new, modern, award-winning[1] five-storey building in 2021, whose design sought to maximise cross-ventilation of rooms, important in a hot and humid tropical country such as Singapore, so as to enhance the comfort of residents.

The new building increased SJH's capacity from 86 to 144 residents, and incorporated elderly-friendly design features, such as slip-free tiles, wider corridors and doorways, and larger bathrooms to accommodate wheelchairs. The improved facilities of SJH also included an open-plan physiotherapy space with state-of-the-art equipment, a hydrotherapy pool, as well as a roof-top garden for communal gardening and living.

### 1.2 'My Guardian Angel'

One of the thrusts to improve the quality of life of SJH residents is to leverage on technology for optimum healthcare, and the introduction of 'My Guardian Angel' is a giant leap in that direction.

[1] The SJH building design won an award at the Asia Pacific Property Awards 2021-2022, and was shortlisted for the World Architecture Festival 2018 Health – Future Project award.

'My Guardian Angel' (MGA) – a wearable device – was funded by the Techbooster Fund of National Council of Social Services (NCSS) in Singapore. The MGA utilizes a sensor monitoring and analytics programme in addition to Bluetooth technology to provide safer and more efficient care for residents vis-à-vis traditional methods of reactive care and routine checks. It monitors a resident's ADL and proactively alerts staff for anomalies that indicate an intervention is required.

One of the main features of MGA is its fall detection capability. Older persons who have experienced falls or near falls can develop a fear of falling, which may lead them to reduce their activities, thereby negatively impacting their quality of life (Ang et al., 2020). A fall detection type device, such as the MGA, monitors for falls and sends help to minimize the consequences of falls (Usmani et al., 2021).

At SJH, if a resident falls (e.g. in the bathroom), the fall is detected by the MGA they are wearing and the location of the fall will pushed to the staff's tablet who is then able to respond immediately. There is also an emergency call button on the MGA for the resident to activate manually should the need arise.

The MGA is also able to detect other anomalies. For example, the failure to maintain personal hygiene or adhere to daily routines may be an indication of self-neglect (Day et al., 2017). Hence, the MGA will alert staff if residents do not attend a meal (i.e. 'Mealtime Attendance Taking) or had not sent their clothes to be laundered after a period of time (i.e. 'Laundry Management System'). Another feature is the 'real time location system' which includes virtual geofencing that is able to detect when a resident ventures into an unsafe location, or enters a restricted area during a certain time period (e.g. at night when visibility is poor).

Last, the MGA also serves as an 'access card' to residents' rooms (i.e. 'Access Control System'), which enhances their privacy as access to their rooms is restricted to only those authorized to enter. The MGA was originally available in two forms – as a 'watch' to be worn on one's wrist, or as a 'necklace' that is hung around one's neck.

*Figure 1: MGA worn on a resident's 'wrist'*

### 1.2.1 Purpose

The purpose of this study was to examine the challenges and benefits of implementing the 'My Guardian Angel' intervention at a Sheltered Home for ambulant older persons in Singapore, as well as to assess the feasibility of such an initiative. The study also aimed to provide practical next steps to improve the implementation of the MGA, as well as to provide

other organisations that are implementing similar technologies with helpful information to avoid the issues and challenges faced in the implementation of MGA. Three central questions guided this study:

a. What challenges did staff of SJH face in the implementation of MGA?
b. What benefits did the implementation of MGA bring to the residents (and staff) of SJH?
c. How feasible is the MGA in detecting falls experienced by SJH residents?

## 2. Methodology

This research adopted an exploratory case study design which sought to better understand the implementation of the 'My Guardian Angel' intervention at St John's Home for Elderly Persons. Specifically, the research sought to review information pertaining to the challenges and benefits of the MGA, as well as its perceived impact in improving the quality of residents' lives.

Although a case study design tends to be qualitative in nature, it could also measure or review quantitative data (Privitera, 2022). Hence, this research adopted a convergent mixed methods approach where "the researcher converges or merges quantitative and qualitative data…at roughly the same time and then integrates the information in the interpretation of the overall results" (Creswell & Creswell, 2018, p. 15).

The research involved a review of existing documents that recorded incidents of falls by residents at SJH. The researcher extracted quantitative data that were assessed to be relevant, for example, the number of falls per month, the number of residents who fell in the same month (to account for repeated falls by the same resident), as well as the number of "unwitnessed falls."

The qualitative documentation of fall incidents also allowed the researcher to observe the "language and words" of staff in an unobtrusive manner (Creswell & Creswell, 2018, p. 188), and also provided 'curiosities' that were further explored during the follow-up informal interviews with staff.

The research would provide an account of SJH and the MGA followed by the analysis of data that led to the themes and issues surfaced. To improve trustworthiness and credibility, the data collected from the various sources were used to triangulate and build a "coherent justification" of the findings presented in this paper (Creswell & Creswell, 2018, p. 200).

## 3. Findings

### 3.1 'Access Control System'

The 'Access Control System' is another simple and helpful feature that benefitted both staff and residents. In the past, residents were free to move between rooms even though they were not its occupants. Moreover, there was no means to restrict their movements to certain areas unless it was physically locked.

Now, residents wearing the MGA device would be able to access their rooms without the need to carry an additional item like a fob or card. This also enhances their privacy as access to their rooms would only be permitted to those who stay there. The geo-fencing feature also

means that access to certain areas such as the rooftop garden can be limited at specified times such as at night where visibility is low and fall risks increases.

A learning point related to the implementation of the 'Access Control System' was on the sensitivity of the MGA device which impacts the time taken for the door to the rooms to be opened. To elaborate on this, the system involves an independent contractor / vendor who authenticates the identity of the 'user' before granting access to the facility such as the room. Hence, the time taken for the system to grant access to the resident may take an inordinate amount of time that is perceived as "taking too long". However, the calibration of sensitivity also has an impact on other areas such as the battery life of the MGA.

### 3.2 'Mealtime Attendance Tracking'

The 'Mealtime Attendance Tracking' was a simple yet helpful feature that benefitted both staff and residents. In the past, this was not feasible as staff could not take the attendance of staff manually; they would rely on either their observations of residents or reports from residents' fellow roommates.

Now, their attendance is automatically logged in the system when residents who are wearing their MGA devices collect their meals at the cafeteria. An alert is sent to staff when a resident fails to show up for their meal within the pre-set duration. One interviewee recounted an incident where a resident had not shown up for breakfast, and a staff member was alerted to this. Upon arriving at the resident's room to check on them, the staff found them with an abnormally low heart rate which required immediate medical attention – this allowed them to intervene and preserve the resident's life.

A learning point related to the implementation of the 'Mealtime attendance tracking' was the duration for the meal set into the system. Previously, a longer duration was set in the system which triggered the alert only at the end of the mealtime. However, this caused issues when the cafeteria had closed and food was no longer available after the staff had checked on the resident and they came down to consume their meal.

Moreover, the intention was for staff to check on residents who may be in distress or require help (as evident in the anecdote above). Hence, the Home experimented with different meal timings, and eventually settled for a shorter but reasonable time frame for the trigger to be set. This new mealtime duration balanced the flexibility residents may appreciate in not rushing them to have their meals early, while giving staff sufficient time to check on residents and intervene for those who may require help.

### 3.3 'Laundry Management System'

The 'Laundry Management System' was a clear benefit from the implementation of the MGA for both staff and residents. This system involved the residents' clothes having an RFID tag which allowed for them to be tracked from the time they are deposited at the laundry room, to the point where they were returned to residents. The previous process was entirely manual, and in addition to being laborious, also resulted in missing or misplaced laundry. It was also not possible previously to track which residents had their clothes washed, or the frequency with which they did so.

Despite its success, there were two issues that surfaced during implementation which staff highlighted, although these had been resolved. The first involved the scanner that tracked the residents' laundry – the staff in charge of implementing this recounted that s/he faced numerous challenges in the placement of the scanner as the placement impacted the sensitivity required to accurately detect and log the residents' laundry. There were instances where duplicate logs were captured for the same load of laundry, whereas others lacked sensitivity and required the staff handling the laundry to manually move the load in order for it to be detected and logged. It appeared that this process involved a fair bit of trail and error, although once the ideal position for the scanner was found, no further issues were encountered.

The second issue that surfaced pertained to the RDIF tags that had to be sewn into the residents' clothes for tracking purposes. Although an industrial machine was purchased for this purpose, the RFID tags were dislodged after a few washes and had to be manually hand-sewn onto the residents' clothes. Fortunately, although this was a massive undertaking in the first instance, subsequently this was only required to be done for new residents or residents' who replaced their clothes.

**3.4 Decrease in "Unwitnessed Falls"**

The decrease in the number of "unwitnessed falls" is one of the key findings in this study. "Unwitnessed falls" are defined broadly by staff as falls that were not witnessed by any party other than the resident who fell, and implies that help could not be immediately rendered or was not reported to SJH staff.

There are generally two scenarios related to "unwitnessed falls" – the first being one in which the resident fell and could not continue, and help could only be rendered when they were discovered by staff or other residents who then provided or activated help. This is illustrated by the following entry in the 'fall incident log':

> *"…the other residents of [room] D6 were all sleeping when [healthcare aide] saw [resident who fell] sitting on the floor during dorm patrol."*

The second scenario were incidents in which the resident fell but was able to continue what they were doing, and did not report the incident. This is illustrated with the following entry into the 'fall incident log':

> *"[Healthcare assistant] noticed [resident's] 4th toe on right foot and left forearm had slight hematoma. Then she asked what happened. The [resident] then said she fell today earlier in the morning inside the bathroom when she showering around 6am, but she didn't inform anybody." Or*
>
> *"When I was going to give [resident] her pre-breakfast medication, she told me last night around 2 am she fell down inside the toilet... but she didn't informed me at that time."*

Although the status of the resident in the above quote was stable, there could be situations whereby residents fell, did not report it, and subsequently experienced a deterioration in their condition. The notion of 'silent fallers' who do not report their fall or seek medical assistance unless they are injured is not uncommon among older persons (Ang et al., 2020). Hence, the

implementation of the MGA allowed for all falls to be investigated, and for healthcare professionals to make an independent assessment of the fallen resident's condition instead of relying on the residents' self-assessments.

It is noteworthy that the MGA did not eliminate "unwitnessed falls." Interviews with staff to understand these incidents revealed that residents may not have been wearing their MGA when they fell. The research literature has found that wearing a fall detection device all the time can be frustrating or annoying, and the older person may also need to remember to wear the device (Hassan et al., 2023). This is consistent with what was found in this study.

### 3.5 Feasibility of the 'Fall Detection' Feature of MGA

The 'fall detection' feature of the MGA was the last component to be tested, and had not been fully implemented for all residents as of 15 May 2023. The initial phase of the implementation of this feature commenced in February 2023 with 15 residents who were assessed to be of 'high fall risk'; 12 additional residents joined the trial in March 2023.

#### 3.5.1 False Positives

Staff recalled false positives (i.e., system sent alert for a fall when no fall actually occurred) were a significant issue at the start of implementation (6 Feb 2023), with one staff stating that there were "multiple triggers through the [first] night" of implementation. The sensitivity settings were adjusted which eliminated the false alerts. However, a review of the records revealed that two falls (by the same resident) were not detected on 19 and 22 February. The sensitivity settings were refined further and the system had stabilised and though there are occasional false positives, usually due to mechanical issues, the staff interviewed no longer cited this as a pressing issue.

Records also indicated that there were issues with some devices which led to false positives. For example, one resident had nine incidents of false positives (falls) over a six day period and is likely indicative of a mechanical fault. As of July 2023, false positives had been minimized to about 2 occurrences a week.

### 3.6 Issues Impacting Feasibility of MGA

#### 3.6.1 Trade-Off Between Battery Life and Sensitivity (of Features of MGA)

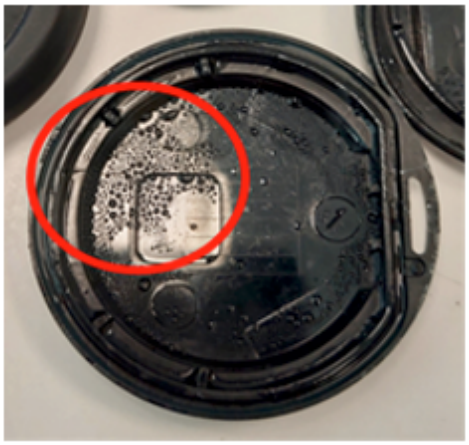
One of the key issues identified in this study pertained to the battery life of the MGA, and ultimately its impact on the feasibility and sustainability of this initiative. Batter power issues or `battery life had been highlighted in the literature as one of the challenges that pervade wearable technologies that support independent living among older persons (Baig et al., 2019; Gettel et al., 2021).

Similarly for the MGA, which utilized non-rechargeable (disposable) batteries, the actual shelf life of the battery varied considerably from the estimate provided by the manufacturer of the MGA – from the two years stated in the contract, to two weeks at one point when the settings on the MGA were tuned to significantly increase its sensitivity. At the time of writing, the average battery lifespan was about three months.

The reasons provided by staff involved in the implementation revolved around the initial estimate being premised on the "minimum" settings being set in the MGA. However, during implementation, this was assessed to be insufficient and had to be increased. For example, at the start, the sensitivity of the 'Access Control System' was insufficient to detect the residents' MGA and resulted in delays in the opening of doors or even in the doors not opening. Therefore, the sensitivity of the MGA had to be increased from baseline to ensure residents gain timely access to their rooms.

The trade-off explicit in this and other similar scenarios posed by the MGA is that the increase in sensitivity setting for the MGA results in a decline in its battery life. Staff also discovered an additional impact on the MGA device's lifespan – when the device was opened for its battery to be changed, the seal that ensured the device was waterproof may not work as well; in some instances, this led to water seepage and damage (Figure 2). All these significantly increased the costs for implementation, and potentially impacts the durability of the MGA device and its long-term feasibility. A second iteration of the wristband is being trialed, and will hopefully increase the durability of the device.

*Figure 2: Water seepage (circled) in the MGA 'watch'*



### 3.6.2 Residents' Compliance With Wearing MGA

The feasibility of the MGA device, especially in detecting falls, is reliant on residents' compliance with wearing MGA. However, this research found that some residents may forget to wear the MGA device, especially when they wake up at night and have to use the bathroom. Moreover, there are other residents who may not "see the need" for the MGA device; this has also been found in other research where older persons did not see a need for fall detection devices or were embarrassed by them (Gettel et al., 2021). This usually means that they do not wear the device, and correspondingly does not reap its benefits, and remains the biggest challenge that will need to be overcome for the MGA device to be implemented successfully.

## 4. Conclusion

The MGA had several clear benefits for the older persons residing at SJH – the Access Control, Mealtime Attendance Taking and Laundry Management Systems appear to improve their Quality of Life such as through enhanced privacy and safety, prompt assistance that is provided when issues are detected and sent to staff, etc.

It appears that part of the reason for its utility lies in the fact that it encompasses several features instead of just being used for one purpose, e.g., fall detection. This means that residents had more reasons to use the MGA device as it would allow them access to their rooms or track their laundry.

One finding was that the long-term sustainability of the MGA device hinged on the ability to balance the sensitivity of settings for the various features of the MGA for them to perform effectively vis-à-vis the battery life span of the MGA device. It appears that these features may need to be calibrated individually when implemented and is not insurmountable.

However, it is acknowledged that the fall detection component is still 'work-in-progress' with the potential to further enhance quality of care of residents. As this study found that some residents still do not use the MGA which led to a few occurrences of "unwitnessed falls," the first recommendation would be to conduct a follow-up study that seeks out the perspective of SJH residents in the use and application of the MGA, specifically exploring the barriers and facilitators of their wearing the MGA.

This could pinpoint factors that lead residents not to use the MGA, and implement tweaks that increase compliance with wearing the MGA while at SJH. Although this was not raised during the study, residents' perspectives could also be sought on any feedback they may have on the MGA, including any privacy concerns they may have.

Although the focus of this study is the implementation of the MGA at SJH, the ultimate goal is for it to have a positive impact on the quality of life (QOL) of residents at SJH. Future studies can incorporate measures to ascertain the impact in this domain.

In conclusion, the key features of the MGA device appear to contribute towards improving the quality of care received by residents of the Home. This is congruent with other research which found that despite challenges faced, the general consensus was that such devices enhanced the independence of older persons using such devices (Gettel et al., 2021).

**Acknowledgment**

This paper is only possible with the support of the Chairman and General Manager of St. John's Home for Elderly Persons, as well as the staff who participated in this research.

**References**


Agency for Integrated Care. (n.d.). *Shelter and Senior Group Home* [Government]. Introduction To Shelters And Senior Group Homes. Retrieved May 15, 2023, from https://www.aic.sg:443/care-services/shelter-and-senior-group-home

Ang, G., Low, S., & How, C. (2020). Approach to falls among the elderly in the community. *Singapore Medical Journal*, *61*(3), 116–121. https://doi.org/10.11622/smedj.2020029

Baig, M. M., Afifi, S., GholamHosseini, H., & Mirza, F. (2019). A Systematic Review of Wearable Sensors and IoT-Based Monitoring Applications for Older Adults – a Focus on Ageing Population and Independent Living. *Journal of Medical Systems*, *43*(8), 233. https://doi.org/10.1007/s10916-019-1365-7

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (Fifth edition). SAGE.

Day, M. R., McCarthy, G., & Fitzpatrick, J. J. (2017). *Self-Neglect in Older Adults: A Global, Evidence-Based Resource for Nurses and Other Healthcare Providers*. Springer Publishing Company, Incorporated.

Gettel, C. J., Chen, K., & Goldberg, E. M. (2021). Dementia Care, Fall Detection, and Ambient-Assisted Living Technologies Help Older Adults Age in Place: A Scoping Review. *Journal of Applied Gerontology*, *40*(12), 1893–1902. https://doi.org/10.1177/07334648211005868

Hassan, Ch. A. U., Karim, F. K., Abbas, A., Iqbal, J., Elmannai, H., Hussain, S., Ullah, S. S., & Khan, M. S. (2023). A Cost-Effective Fall-Detection Framework for the Elderly Using Sensor-Based Technologies. *Sustainability*, *15*(5), 3982. https://doi.org/10.3390/su15053982

Health Promotion Board. (2015). *Falls prevention among older adults living in the community* (Clinical Practice Guidelines 1; p. 52). Health Promotion Board. https://www.hpb.gov.sg/docs/default-source/pdf/cpg_falls_preventionb274.pdf?sfvrsn=abedeb72_0

Lee, C. M., Lin, D., & Wong, W. X. (2022). Key Highlights from the National Population Health Survey 2020. *Statistics Singapore Newsletter*, *1*, 5.

Lim, C. H., & Ng, J. M. M. (2015). Mobilising social care for the family physicians. *The Singapore Family Physician*, *41*(1), 32–45.

Ministry of Health. (2023, January 30). *MOH | News Highlights* [Government]. Launch of the 2023 Action Plan for Successful Ageing. https://www.moh.gov.sg/news-highlights/details/launch-of-the-2023-action-plan-for-successful-ageing

National Population and Talent Division, Singapore Department of Statistics, Ministry of Home Affairs, Immigration & Checkpoints Authority, & Ministry of Manpower. (2022). *Population in Brief 2022* (p. 32) [Government]. https://www.strategygroup.gov.sg/files/media-centre/publications/Population-in-Brief-2022.pdf

Privitera, G. J. (2022). *Research methods for the behavioral sciences* (Updated third edition). SAGE.

Usmani, S., Saboor, A., Haris, M., Khan, M. A., & Park, H. (2021). Latest Research Trends in Fall Detection and Prevention Using Machine Learning: A Systematic Review. *Sensors (Basel, Switzerland)*, *21*(15), 5134. https://doi.org/10.3390/s21155134

World Health Organization. (2018). *Global action plan on physical activity 2018–2030: More active people for a healthier world*. World Health Organization. https://apps.who.int/iris/handle/10665/272722